CRC Construction Innovation

BUILDING OUR FUTURE

Report
A Comparative Study – Regulatory Requirements on Subdivisions for Increasing Passive Cooling

Research Project No: 2002-077-B-03

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ABBREVIATIONS

ACT	Australian Capital Territory
ACTHERS	ACT House Energy Rating Scheme
ACT PLA	Australian Capital Territory Planning and Land Authority
AGO	Australian Greenhouse Office
BASIX	Building Sustainability Index
BCA	Building Code of Australia
BCC	Brisbane City Council
BoM	Bureau of Meteorology
CSD	Centre for Subtropical Design
CRC CI	Cooperative Research Centre for Construction Innovation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DA	Development Application
DCP	Development Control Precinct
EER	Energy Efficiency Rating
EPA	Environmental Protection Authority
ESD	Environmentally Sustainable Design
GCCC	Gold Coast City Council
GHG	Green House Gas
HER	House Energy Rating
IPA	Integrated Planning Act
LGA	Local Government Authority
NSW	New South Wales
NT	Northern Territory
PC	Performance Criteria
QDC	Queensland Development Code
QDPW	Queensland Department of Public Works
QLD	Queensland
QUT	Queensland University of Technology
SA	South Australia
SEAV	Sustainable Energy Authority of Victoria
SEDA	Sustainable Energy Development Authority
SEQ	South East Queensland
TAS	Tasmania
VIC	Victoria

PREFACE

A major project in the Sustainable Built Assets core area is the Sustainable Sub-divisions – Ventilation Project that is the second stage of a planned series of research projects focusing on sustainable sub-divisions.

The initial project, Sustainable Sub-divisions: Energy focused on energy efficiency and examined the link between dwelling energy efficiency and sub-divisional layout. In addition, the potential for on site electricity generation, especially in medium and high-density developments, was also examined. That project recommended that an existing lot-rating methodology be adapted for use in SEQ through the inclusion of sub divisional appropriate ventilation data. Acquiring that data is the object of this project.

The Sustainable Sub-divisions; Ventilation Project will produce a series of reports. The first report (Report 2002-077-B-01) summarised the results from an industry workshop and interviews that were conducted to ascertain the current attitudes and methodologies used in contemporary sub-division design in South East Queensland.

The second report (Report 2002-077-B-02) described how the project is being delivered as outlined in the Project Agreement. It included the selection of the case study dwellings and monitoring equipment and data management process.

This third report (Report 2002-077-B-03) provides an analysis and review of the approaches recommended by leading experts, government bodies and professional organizations throughout Australia that aim to increase the potential for passive cooling and heating at the subdivision stage. This data will inform issues discussed on the development of the enhanced lot-rating methodology in other reports of this series.

The final report, due in June 2007, will detail the analysis of data for winter 2006 and summer 2007, leading to the development and delivery of the enhanced lot-rating methodology.

EXECUTIVE SUMMARY

Objective

This is the third in a series of reports planned for this project. The aim of this research is to conduct a comparative study of current legislation or guidelines at the federal, state and local government levels to confirm if any natural ventilation criteria are required at the subdivision development stage of planning.

It also seeks to discover if there are any other incentives, statutory planning or development principles that encourage developers to orient subdivision lots to maximize natural ventilation for the dwellings.

Findings from the research in this report are intended to contribute to the discussion on the development of an enhanced lot rating methodology for sustainable subdivisions as documented in other reports in this series.

Research Methodology

A desktop review / web search was conducted to identify existing legislation and general guidelines regarding the incorporation of natural ventilation at subdivision planning stage.

Research data on legislative policies is compiled and presented in table format for comparison of the various approaches adopted by the different States.

Limits of the Research

The research seeks to focus on the main pieces of legislation or widely acknowledged general principles that immediately affect the topic of lot orientation with regard to natural ventilation. Though some references are made in this report to sustainable development principles adopted or produced at State or Local government levels, this research does not seek to report on such recommendations extensively.

Other factors such as topography, microclimates and surrounding vegetation that have a significant impact on the availability of breezes to dwellings and lots are not discussed in this report as the focus is primarily on the legislative aspects of natural ventilation criteria on subdivision planning. However, in-depth discussion on how passive ventilation is affected by topography, shelterbelts and building design can be found in our previous report Sustainable Subdivisions: Ventilation report 2002-077-B01 published Nov 2006.

Similarly, no discussion on the conflicts that could arise between breeze and solar capture in lot or building configurations or issues of cost are addressed in this report due to the defined aim of this research.

Main findings

This research confirmed that many of the regulatory requirements for energy efficiency or initiatives for sustainability focused on the building itself or the orientation of the dwelling on the lot. There is little or almost no specific regulatory requirement for the orientation of the lot itself for natural ventilation, though there are expected criteria to be met for the orientation of the lot for solar access.

It was also found that references to natural ventilation usually referred to the building enclosure, that is, position of windows on a building rather that the siting of the building on the site to capture prevailing breezes.

This research also revealed that there are significantly more references to solar orientation of

dwellings on lots than for the harnessing of breezes for natural cooling.

Similarly, the guiding principles for increasing energy efficiency or reduction of greenhouse gas emissions for subdivision planning do not specifically refer to increasing passive ventilation with lot orientation. Rather the orientation of lots to maximise natural ventilation is usually included in siting for overall microclimatic conditions.

There seems to be a general understanding of the importance of lot or building siting for effective passive cooling by prevailing breezes but there is not as much direct reference as can be found for solar orientation.

Our Comparative Study of current legislation and guidelines at different levels of government indicates that there are various general inferences rather than specific performance based design criteria for natural ventilation in sustainable subdivisions. Energy savings are acknowledged as a possible outcome of correct orientation but no overt ratings are used for natural ventilation criteria.

Due to the lack of legislation that relates specifically to the orientation of lots for natural ventilation, the discussion of regulations versus voluntary compliance is a topic that is relevant to this discussion.

Our research carried out for this report revealed that different state and local governments have their own legislative framework for sustainability and energy reduction in relation to buildings or subdivisions. There is no uniformity among the States though many of these criteria are adapted from general principles that are put forward by national government agencies.

1. INTRODUCTION

This is the third in a series of reports that will detail the findings of the project. The first report (2002-77-B-01) prepared by the Centre for Subtropical Design, summarised the results of an industry workshop and interviews that were conducted by CSD throughout April 2006 to ascertain the current attitudes and methodologies used in contemporary sub-division design in South East Queensland (SEQ).

The second report (2002-077-B-02) described how the project was delivered as outlined in the Project Agreement. It covered the period from commencement in January 2006 to 30 June 2006. Included were case study lot selection, data monitoring equipment selection and data management process.

This third report (2002-077-B-03) summarises CSD research on existing legislation, current guidelines and good practice development principles that encourage developers to orient subdivision lots to maximise natural ventilation for dwellings.

1.1 Report Structure

This report will be delivered in three sections:

Section 2 Climatic Zones

The notion of orientation of subdivisions or orientation of dwellings on subdivision lots cannot be explored without its relationship to the climatic zone it is in. This section will give a brief overview of the zoning currently used in Australia.

Section 3 Guidelines

This section presents currently available information from government bodies and other professional organisations that may affect subdivision planning with respect to passive ventilation.

Section 4 – 5 Legislative framework and Comparative Study

This section presents a comparative study of current legislation that could affect subdivision planning in relation to passive ventilation. Investigation is carried out at different levels of government and is presented in a table format.

2. CLIMATIC ZONES

2.1 Thermal comfort

A discussion of climatic zones needs to be prefaced with a brief overview of the elements of thermal comfort, that is, what causes us to be neither too hot nor too cold. A summary of information from the Bureau of Meteorology[1] and S. Szokolay.[2] notes factors affecting human thermal comfort as:

1. Temperature
    a. dry-bulb air temperature, which determines convective heat exchange between the body and its surrounding air
    b. radiant temperature, which determines the exchange of thermal radiation between the body and surrounding surfaces
2. Humidity
    a. refers to the amount of water vapour in the air
    b. high humidity can be uncomfortable as the evaporation from the skin is hampered
3. Air Movement
    a. is measured by its velocity
    b. does not reduce air temperature but increases evaporation of moisture from the skin (i.e. evaporative cooling unless humidity is too high)
4. Activity rate
5. Clothing level

2.2 Wind Speed

The “Feasibility Study – A National Approach to Energy Efficiency Measures for Houses”, produced by the AGO, points out that wind speed data needs to be considered in design as most approaches to climate zoning include dry bulb temperature and humidity data only. “One of the dominant factors that determine indoor air speeds is the house spacing-to-height ratio. The exposure of houses to wind for natural ventilation will range from full exposure for an isolated house to very restricted exposure for houses on small lots (as small as 250m^2 and typically around 300m^2) in current AMCORD-driven housing subdivisions. This must be taken into account when determining the available driving forces for natural ventilation.”[3] pg.34.

2.3 Climatic zones

As the Project Agreement requires that the enhanced lot-rating methodology be relevant to all Australian states, this section will describe the climatic conditions that will influence such a methodology. All climate zones in Australia have the potential for passive cooling through natural ventilation in the warmer months and the following section of the report will provide an overview of this possibility within the different climatic zones.

The Bureau of Meteorology (BoM), with 3 or 6 zones, Building Code of Australia (BCA), with 8 zones, and Australian Model Code for Residential Development (AMCORD), with 4 zones with 4 sub-regions, have different classifications of climatic zones.

The BoM has informative examples of urban and house design that are appropriate for the climate. It has a 3-zone classification[4] for its discussion on Climate Zones for Urban Design (BoM):

1. Hot-dry
2. Warm-humid
3. Temperate

But it uses a 6-zone classification[5] when referring to Comfortable, Low-energy Homes (BoM):

1. Hot humid summer, warm winter
2. Warm humid summer, mild winter
3. Hot dry summer with mild winter
4. Hot dry summer with cool winter
5. Warm summer, cool winter
6. Mild to warm summer, cold winter

This contrasts with the BCA which divides the country into 8 zones[1] for dwelling design, and also with AMCORD's 4 zones:

1. Temperate
2. Cool-Temperate
3. Hot-Humid
4. Hot-Arid

To add more confusion, AMCORD[6] lists the 4 generalized climate zones (as noted above) in its section on Design for Climate Element 5.10 but within each of those zones, in Practice Note PND 19, there are further sub-regions to more accurately describe its characteristics, for example:

Hot-Humid Tropics (AMCORD) includes:

1. Far Northern Tropics
2. North Queensland Coast
3. Transitional Zone
4. Subtropics

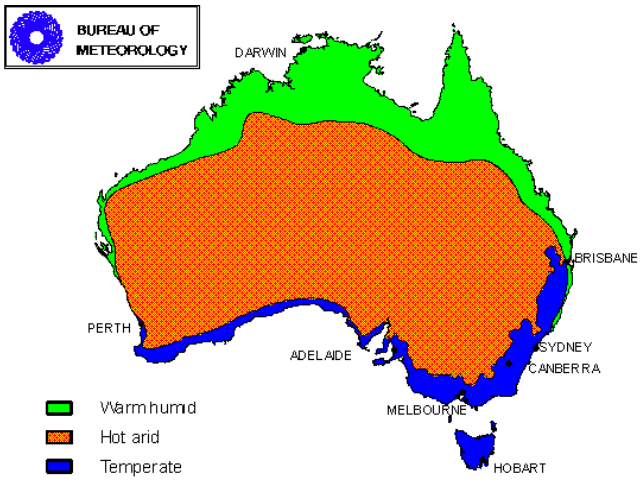
These differences may cause some confusion as subtropical Coolangatta would be classified as Hot Humid under AMCORD or Warm humid summer, mild winter under BoM's 6-zone classification, but is classified as Temperate climate under the BoM's 3-zone classification for urban design. This inconsistency makes it difficult to make direct comparisons but for the purpose of the discussion that follows, the BoM's 3-zone classification for urban design (see Fig. 8.1 below) will be used in order to get a broad overview of the major differences in the way air movement affects dwelling and street layout under different climatic conditions.

The following section briefly describes climate, breezes and street or house layout under the BoM's 3-zone classification. Climatic zones alone do not determine the availability of breezes on a house or lot but the following section is meant to illustrate that climatic variations of Australia are a starting point in the discussion of the importance of breezes in street and lot layout.

Orientation, topography and microclimates have considerable effect on the availability of breezes to a subdivision or a house. For in-depth discussion on the effects of topography and surrounding vegetation (shelterbelts and windbreaks) on passive ventilation, please refer to our previous report Sustainable Subdivisions: Ventilation report 2002-077-B01 published Nov 2006.

[1] The 8 zones in the BCA are not given any categorical or descriptive names but are just listed as Zones 1 - 8

Figure 2-1 BoM urban climate zones



2.4 Temperate climate

The majority of capital cities, including parts of Perth but not Brisbane or Darwin, are located in this zone:

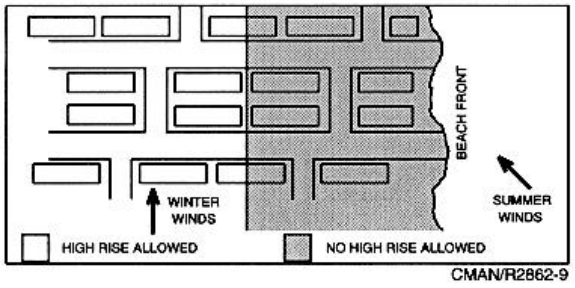
> The temperate climate has mild to warm summers and cool winters. The need for winter home heating is greater than the need for summer cooling. It is a relatively comfortable climate, especially near the coast, where summers are cooler and winters warmer than further inland. In the mountains of the Great Dividing Range, winters are cold and summers are pleasantly mild.
>
> Definition for zone boundary**:** mean January maximum temperature <= 30 degrees Celsius (Australian research suggests a temperature of 29.5 degrees Celsius as the upper limit for human thermal comfort) AND 3 pm January water vapour pressure <= 2.1 kPa (this is about the upper humidity limit for thermal comfort: the American Society of Heating, Refrigerating and Air-conditioning Engineers use 1.87 kPa as the upper limit) [4]

The BoM recommends that choosing a street layout which will **block the winter wind, yet allow cooling summer breezes through**[2] will be one of the strategies for a climate-sensitive urban design. The street layout example, given in Fig. 2.2, is modelled on Coolangatta. It should be pointed out, that in actuality, the street is laid out in the opposite direction, with high rises close to the beachfront.

While “access to winter sunshine is the top priority…**shelter from cold winter winds** is also a consideration” for a building block.

[2] References to natural ventilation and access to breezes in this and all following quotes are bolded for convenience but were not bolded in original text

Figure 2-2 Preferred Coolangatta Street Layout



2.5 Hot Dry climate

Places in this category would be Longreach and Alice Springs and parts of Perth. The primary aim is winter solar heat gain and summer cooling, where shading from the sun is important. In this climate, there is more emphasis on summer shading and minimising winter house drafts. If breezes are available, the house design would work best with water features or plants nearby to enable evaporative cooling.

> In this climate, summers are hot to very hot and it seldom rains. Winter days may be cool or warm, and winter nights can be very cold. The air is dry, there is little cloud; sunshine is intense and glare can be a problem. There is a big temperature difference between day and night.
>
> Definition for zone boundary: mean January maximum temperature > 30 degrees C AND 3 pm January water vapour pressure <= 2.1 kPa [4]

2.6 Warm humid climate

Brisbane, Darwin, northern and coastal Queensland and north coast NSW fall into this zone. Air movement is important for thermal comfort in this zone and the BoM recommends that "streets and buildings are oriented to catch the breezes. A mix of building heights promotes ventilation. Vegetation must not impede air movement: trees with branches far from the ground, such as palms, would be ideal."[3]

> Summers in this climatic zone are warm, and very humid. In most parts of the zone, summer will be rainy. Winters are warm, dry and sunny. Coastal areas are subject to tropical cyclones (also known as hurricanes). The summer climate is stressful. It is the least comfortable Australian climate. The body's natural cooling system (the evaporation of perspiration) does not work well, because the air is already so full of water vapour that it cannot hold much more.
>
> Definition for zone boundary: mean January water vapour pressure >= 2.1 kPa (most places meeting this criterion also have a wet bulb temperature of about 24 degrees Celsius or more, which is the upper limit for any effect from evaporative cooling. [4]

In the section Comfortable, Low-Energy Homes, where the BoM applies 6 zones, cities that fall roughly into this Warm Humid category would be Brisbane and Darwin, where it is noted that for subtropical areas, "**access to summer breezes is important** " while for hot tropical areas, "**air movement is crucial**, to help perspiration to evaporate". Elevation of houses to catch breezes may be applicable and garden layout should not block summer breezes. "**In a new subdivision, the spacing of buildings should be carefully considered to avoid obstruction of the wind.**"[5]

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[3] The Centre for Subtropical Design recommends that large trees be used for shade because palms do not contribute greatly to the microclimatic conditions around a building as much as shade trees. The species, varying heights of trees chosen and their positioning are the elements that affect air movement around a building or on a street.

3. GUIDELINES

Existing non-legislative policies and guidelines provide invaluable information on subdivision design. Though they are voluntary, these guidelines have been sourced to provide principles to guide national, state or local government policies. Passive cooling from proper lot orientation is understood as an important consideration for increasing energy efficiency of dwellings, thereby reducing Greenhouse Gas (GHG) emissions.

Guidelines affecting subdivision planning in response to climate are being encouraged nationally by organisations such as the Urban Development Institute of Australia (UDIA) and by the Commonwealth Government through departments such as the Australian Greenhouse Office (AGO) and programs such as Cities for Climate Protection (CCP). These guidelines and other energy efficient programs encourage local councils to adopt them into their local codes and schemes.

Many state governments and local councils have been proactive and have adopted various environmental and sustainable principles to focus on energy efficiency in its urban development policies. In "South Australia's draft greenhouse strategy – tackling climate change 2006", the objective stated on pg. 41 in section 7.4 Urban Planning and Design is to "develop sustainable built environments that are responsive to climate change". It is pointed out in this report that:

> "climate change needs to be tackled at all levels of urban planning and design not just individual buildings or infrastructure. It requires integrated approaches, including the integration of solutions for reducing emissions (e.g. energy-efficient subdivision layouts) and adapting to climate change (e.g. stormwater re-use opportunities through water-sensitive urban design)" [7]

Comprehensive information on site planning relating to climate can also be obtained through the nationally recognised AMCORD[4] and the BoM. Other sources such as YourHome Technical Manual on the AGO website also provide educational information to consumers who in turn could influence the developer to consider passive ventilation in subdivision planning. Findings in other studies and research by institutions such as the RAIA also enhance the knowledge for passive cooling with proper lot orientation.

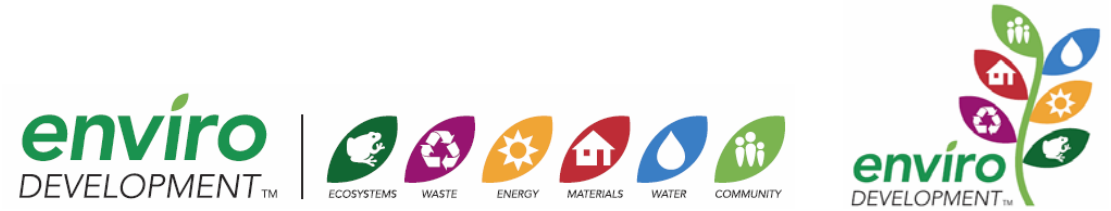
3.1 Urban Development Institute of Australia (Queensland)

The UDIA (Qld) is the peak body representing the development industry in Queensland and has developed an incentives-based certification scheme called EnviroDevelopment in conjunction with State and local governments and other stakeholders, to actively encourage enhanced sustainability outcomes in new developments.[8]

EnviroDevelopment is performance-based and is a branding system. EnviroDevelopment certification involves developers obtaining the right to display the EnviroDevelopment logo after meeting specified requirements in the areas of ecosystems, waste, energy, materials, water and community. "The energy efficiency section in particular **aims to improve lot layout** through considering solar orientation and climate considerations. It also encourages design for energy efficient dwellings, including...cross ventilation and less reliance on air conditioners" [9]

[4] AMCORD will be described in greater detail in Section 4 – legislative framework

Figure 3-1 EnviroDevelopment Logo



One of the criteria to be met under the Energy section of the EnviroDevelopment certification, i.e. Criterion 3.1.1 Essential Actions states that "developments must be masterplanned to facilitate passive design of buildings on at least 75% of the lots." This mainly refers to solar orientation of lots but Criterion 3.1.2 partly refers to ventilation – "Development should show evidence that shielding from hot summer sun, **ventilation** and topography have been considered and addressed". Appropriate evidence in plans and statement from masterplanner and developer are to be submitted as approval by the Board of Management prior to certification as an EnviroDevelopment. [10]

3.2 Cities for Climate Protection

Over 100 local councils have committed to reducing their greenhouse gas emissions by progressing through five milestones as developed by the CCP™ Australia program that is funded by the Commonwealth Government and delivered through a partnership of the Australian Greenhouse Office and the International Council for Local Environmental Initiatives (ICLEI)[5]

Two of the Greenhouse Action Modules implemented by local councils to address energy efficiency in the residential sector were the introduction of Greenhouse Homes in 2000 and FirstRate house energy rating which were aimed at "implementing **appropriate residential planning for energy efficiency** measures in a consistent and transparent manner."[11] The intent of the Greenhouse Homes in this module was to focus on subdivision planning and building design.

Local councils that have adopted these aims have developed various local codes to address energy efficiency in residential planning as shown in the second part of this report. However, the topic of lot orientation for ventilation is usually mentioned as part of the bigger picture of subdivision design in response to climatic conditions.

3.3 Australian Greenhouse Office

In the "Guidelines for influencing the development process for medium density and greenfields development Feb 2002"[12], the AGO recommends that "mandatory energy efficiency requirements from urban design and building types" should be incorporated into planning schemes and that guidelines should be developed "for design of greenhouse-efficient sub-divisions on development sites in the locality (for example, treed sites would be designed to retain vegetation and **maximise climate modification**)"

Using general policies of the State governments, the AGO encourages local councils to "promote the abatement of greenhouse gas emissions through land use planning and urban design." – refer to the report "Reducing greenhouse emissions through planning and urban design: what local governments can do."[13] In these broad terms, the AGO encourages the

[5] The International Council for Local Environmental Initiatives became "ICLEI - Local Governments for Sustainability" – refer http://www.iclei.org/index.php?id=2291 and http://www.iclei.org/index.php?id=whatisiclei

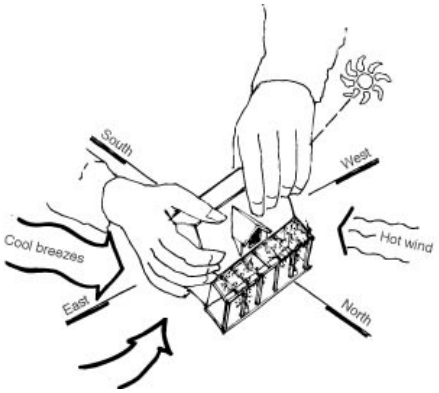
development of a **greenhouse gas rating system for greenfields development.**

In 1999, the AGO also produced a "Scoping Study of Minimum Energy Performance Requirements for Incorporation into the Building Code of Australia"[14] which described on pg.1 "the scope for incorporating minimum energy performance requirements into the Building Code of Australia (BCA)". The objective of introducing these energy provisions into the BCA was to reduce GHG emissions from the building sector. Though the study concentrated on the building itself, it commented on pg. 46 that although land subdivision fell outside the scope of the BCA, energy efficiency can be addressed at the planning application and subdivision stage because land subdivision that promoted good solar access and **appropriate orientation for housing** could improve building energy efficiency and/or reduce GHG emissions.

It was also noted in this study that the Australian Building Energy Council (ABEC), with the support from the AGO, is developing a "Voluntary Code of Practice for Energy Efficient Building Design" to encourage designers to go beyond the minimum requirements of the BCA.

"Your Home" [15] is a suite of technical guide materials developed for consumers by the AGO to encourage the design of more comfortable and environmentally sustainable homes. Section 1.3 Orientation encourages consumers to choose a design "with **maximum exposure to cooling breezes**…" and to look for a home that "can be positioned on your site to **capture cooling breezes**, particularly to living areas"

Figure 3-2 Position home on site to capture cooling breezes – Your Home Technical Manual



Consumers are also encouraged in section 1.5 Passive Cooling to ensure that design principles are specific to the climatic zone, for example, for sub-tropical climates, "orient to maximise exposure to cooling breezes…and elevated structures can **increase exposure to breezes**" while evaporative cooling is encouraged for the hot arid climate.

The report "Australian Residential Building Sector Greenhouse Gas Emissions 1990-2010" published by the AGO in 1999 sought to determine a baseline for GHG emissions and found that about 15% of the GHG emissions attributable to the residential sector in 1998 was a result of the householders' need to heat and cool dwellings.

One of the conclusions of the study linked improved orientation with energy efficiency, albeit mainly referring to solar orientation – "should it be decided that new housing stock will be required to meet more stringent thermal performance standards, then the need for **land subdivision design to address the issue of solar access and building orientation** will be a necessary adjunct to such a program. One of the most cost effective ways to producing more thermally efficient housing is through improved orientation and glazing placement (i.e. passive solar design principles)."[16]

3.4 State Government and Local Councils

State and local governments have developed various strategies for urban planning and design in order to address energy use and GHG emissions. Although some of the energy efficient guidelines that have been developed on pgs. 9 and 13 of "South Australia's draft greenhouse strategy Building Issues paper – tackling climate change 2006", are still quite broad in scope when they are considered at the subdivision planning stage, they underscore the fact that passive design principles which respond to climatic conditions and solar orientation instead of design of allotments for maximum yield will have a significant impact on reduced energy use, thereby fulfilling the aims of the national and state Greenhouse Strategy. [17]

The "Victorian Greenhouse Neighbourhood Project (1993)"[18] explored the relationship between greenhouse gas emissions, energy requirements and the form and design of new neighbourhoods on the urban fringe of Melbourne. The study found substantial energy savings with different forms of dwelling design and orientation of dwelling. Other issues such as the means of transport used and the density of the urban form also impacted on energy use. It notes on pg.21 that the 'ideal' greenhouse neighbourhood will need to consider requirements such as "housing energy, with **lots and dwellings sited,** designed and equipped to minimise their energy requirements" However on pg.13, all the energy calculations for heating and cooling requirements relate to solar orientation of a standard dwelling on a given star-rated lot (Solar Access for Lots rating scheme).

The "Guidelines for Sustainable Development" is a resource document published by the Brisbane City Council to provide advice on sustainable practices that fall within the Brisbane City Plan 2000. It was meant as a resource for builders and developers in the Development Application process. Principle 07 – Manage Energy Use provides guidelines for passive design by capitalizing on elements such as the sun's energy and breezes rather than mechanically heating and cooling buildings – "**in Brisbane, the value of capturing breezes can be as significant as good solar orientation**."[19]

Some councils have a more encompassing perspective of urban or dwelling design in relation to energy efficiency. However, typically, many of the principles relating to land subdivision usually refer to solar orientation of lots such as can be found on pg. 33 of the "Northern Adelaide Greenhouse Management Community Action Plan".[20]

Other state policies and guidelines at local government level will be described further in the second part of this report under Legislative Framework.

3.5 Other Research

The BDP Environment Design Guide (EDG) is a product of the Australian Council of Building Design Professions (BDP) and is a series of professional literature published quarterly by the Royal Australian Institute of Architects (RAIA). Several articles have been published by experts to address built environment sustainable development issues such as how site planning can contribute to energy efficiency and environmental sustainability of residential development.

It is acknowledged on page 3 of GEN 17 Feb 2004 Urban Planning for Sustainability, by Matthew Ulterino, that lot layout is an important factor that contributes to passive cooling – "site planning and individual building codes need to also consider passive ventilation factors to situate and design buildings so that outdoor air moves through a space and creates a cooling effect through convection and air flow." [21]

In their article Residential Site Analysis: For Energy Efficiency and Sustainability, Steve King and David Rudder[22] advise that "although good individual house design can overcome some of the disadvantages which may be inherent in a poor site, thermal performance can best be optimised where site characteristics facilitate solar access and **make favourable**

use of air movement for summer cooling. Subdivision layout and individual lot design are therefore important considerations for energy efficiency."

Figure 3-3 Site plan HMAS Coonawarra - Housing for the hot humid tropics designed for infiltration of cooling breezes – (Troppo Architects Pty Ltd)

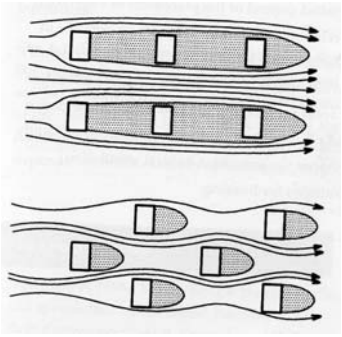
A site analysis checklist includes microclimate such as identifying "the prevailing winds in relation to terrain and existing vegetation, for their potential influence on outdoor thermal comfort and bushfire risk." [22]

Two of the important criteria in the suggested site development checklist of "Residential Site Development – for Energy Efficiency and Sustainability" by the same authors,[23], include solar access and winds. Design for solar access entails maximising "east-west streets to enable favourable allotment design for solar access" while **avoiding orientation of "streets in the direction of unfavourable winds**. Design street and broad planting to **funnel cooling breezes**...Tree shelterbelts are to be used to protect from unfavourable winds – **place perpendicular to wind direction**." [23]

Further explained in more detail in their book, "Site Planning in Australia: Strategies for energy efficient residential planning",[24] the authors state on pg 55 that "air movement is one of the critical factors affecting the thermal performance of dwellings and the overall **life-cycle costs of a residential development**" whereby hot winds in summer can create the need for energy-intensive means of cooling and inversely, in winter, cold winds can increase heat loss from houses and raise demand for energy-intensive heating.

Also, chapter 8 Wind and Ventilation explains further how climate, topography and wind are determinants that subdivision planning needs to consider. Skilful design of subdivisions that take advantage of cooling breezes in warm humid climates will lead to higher standards of thermal comfort without increasing energy expenditure. On pg. 155, [24] it states that grid layouts of single storey houses aligned with the prevailing breeze direction should be avoided as this creates stagnant air zones at least six times the height of the houses. "In contrast, with staggered layouts in a checkerboard pattern, the flow field is much more uniform, and stagnant air zones are almost eliminated." Refer Fig 3-4 below.

Figure 3-4 Avoiding wind shadows – Illustration[6] taken from "Site Planning in Australia" (Ref 24)



Within a subtropical climate, Deicke Richard's report "Subtropical Neighbourhood Design" [25] investigates six neighbourhood case studies to discover how to improve the design of residential subdivisions within a subtropical context. Six principles were put forward on pg.41 that affect good neighbourhood design and one of the elements highlighted was the "**importance of good lot and street orientation for buildings to capture prevailing breezes** and respond to climate."

Skinner in his article "When a little is a Lot: an architect's view" [26], advocates that good design principles such as good orientation, sun-shading and cross-ventilation can work well as a means of climate control even on small lots and he gives examples of how to work within the limits of the Small-lot Housing Code.

3.6 Energy performance standards

A search of the literature for this report has found that energy performance standards for the building envelope have been developed and are embodied in energy rating schemes such as NatHERS and BASIX, which are currently incorporated into local codes in some states such as ACT, NSW and Victoria. However, there are no available rating systems for site design. Consequently, there are no energy performance standards for subdivision planning, hence the absence of a lot rating methodology.

The AGO notes that there is a lack of information on "baseline *GHG* emissions associated with standard subdivision and building design" that can be used to assess the impacts of new design and building practices. Thus, "local governments are generally not yet able to integrate building energy-efficiency models with energy-efficient urban development and transport models." [27]

[6] Though this illustration is taken from King and Rudder's book, "Site Planning in Australia", the authors credit the information to Koenigsberger, O. 1974, *Manual of Tropical Housing and Building: Part 1 Climatic Design*, Longman, London

4. LEGISLATIVE FRAMEWORK

Generally, a local government produces the codes and policies governing subdivision planning and lot layout. These rules have been adapted from a variety of State planning policies which in turn were developed from the Australian Model Code for Residential Development (AMCORD). Other national documents that have informed the formulation of local codes have been Solar Access for Lots by SEDA (Sustainable Energy Development Authority), Building Code of Australia, and Energy Rating tools such as BASIX, NatHERS and FirstRate.[7]

4.1 AMCORD

The Australian Model Code for Residential Development (AMCORD)[6] is a national resource document for residential development to advance planning, design, assessment and implementation of residential development (other than high rise). It is the Commonwealth Government's urban reform agenda relating to housing policy and development.

AMCORD is not a statutory document with legal force but its guidelines are adapted by State or local governments to produce local codes and policies. AMCORD promotes a performance-based system of control rather than specifying prescriptive standards.

4.1.1 Performance-based Criteria

AMCORD is structured into 3 sections:

Setting the Context – This part of the document gives an overview of the urban management framework in which AMCORD can provide the principles and processes for a more effective regulatory environment.

Design Elements. This section discusses design issues and provides designers, developers and planning authorities a basis for design and residential development control that would lead to higher quality urban design outcomes.

In the Design Elements sections, there are recommendations for lot layouts. Lots are encouraged to be "orientated to facilitate the siting of dwellings to take advantage of microclimatic benefits…to allow…**access to breezes**" and this is listed as Performance Criterion P6 in Element 5.2 Lot Layout section of Design Elements, for which an Acceptable Solution is listed as "75% of lots in new residential areas having a 3-star rating or higher in accordance with the National House Energy Rating Scheme (or State Scheme if appropriate.)"[6]

The document also recognizes in Element 5.4 Building Envelope and Siting that overshadowing in building design is not as significant in hot-humid tropics as in temperate regions (*wherein sub-tropics is identified as a sub-region*)[8] but that "**blocking prevailing breezes to neighbouring houses is to be avoided**." However, no specific Performance Criteria for avoiding the blocking of prevailing winds are listed under this section.

Planning Practice Notes are also part of AMCORD and these provide information on design topics such as climatic responsive design for dwellings and lots.

It recommends in Planning Practice Note PNP 10 that dwellings should be sited for solar access and breezes to maximise comfort and that "skewed or oblique lots" may offer some

[7] All legislation referred to in this Overview section will be annotated in the Comparative Study Table in Section 3 and also identified in the References at the end of this report.

[8] Information in italics is not in original phrase but was explained earlier in the document

advantages in special situations to "**catch prevailing breezes**". [6]

Proper use of landscape is identified as effective for "*channelling desirable breezes*" in Planning Practice Note PNP 19. It also recommends that in parts of Australia that are sub-tropical e.g. northern NSW and southern Qld, "tree species **which filter, rather than block breeze access, ventilation by convection**…are desirable"

This Practice Note also states that "the major site planning consideration is to achieve *access to prevailing and/or sea breezes*, and the provision of shade to living areas and private open space…" Two of the key principles to consider are "solar control and **ventilation through cross ventilation**…" PNP 19 also advises that "on small lots, two-storey construction is usually necessary to minimise site coverage and **encourage natural ventilation**..."[6, p. 2]

4.2 Codes, Schemes, Policies and Guidelines

The reference document which all the State and local governments use to design their land planning and building policies, guidelines and schemes is AMCORD. Generally, the State Government lays out its Planning Policies and using this template, the Local Governments then adopt the standards given and adapt those that are appropriate to each Council.

In **Queensland**, the Integrated Planning Act (IPA) is the primary legislation affecting planning and development in Queensland. All development has to comply with Local Government Planning Schemes which in turn is assessed against the IPA requirements, the Queensland Development Code and other regional requirements such as the SEQ Regional Plan 2005-2026.

In **Western Australia**, the Western Australia Planning Commission (WAPC) is a statutory authority under the Department for Planning and Infrastructure and is the legislative body governing all planning and subdivision approvals in conjunction with Regional and Local Planning Schemes. Residential design codes (R-Codes) and Liveable Neighbourhoods operational policy are also part of the subdivision approval process.

In **Victoria**, local planning schemes are informed by the state's Victoria Planning Provisions which provides a template for standard planning provisions. The ResCode and Sustainable Neighbourhoods provisions, which are issued by the Department of Sustainability and Environment, set out objectives for subdivision design while Sustainability Victoria (SV) advocates the minimum five-star rating for residential homes.

In **New South Wales**, the submission of a Building Sustainability Index (BASIX) certificate is required for all Development Applications (DA). The Solar Access for Lots document by SEDA is also a guideline in use for residential subdivision in NSW.

In the **ACT**, all Development Applications and houses for sale have to be accompanied by an ACT House Energy Rating (ACTHERS). Other documents such as the Territory Plan, ACT Residential Guidelines and Achieving Sustainable Residential Development (by the ACT Planning and Land Authority) also guide subdivision planning in the ACT. However, only the ACTHERS and Territory Plan are required under legislation.

In **South Australia**, Development Plans of the various councils derive their legislative framework from the Development Act and State Planning Strategies. The South Australian Housing Code together with the BCA governs building construction in SA while the Good Residential Design SA and various Sustainable Energy policies provide planning and design guidelines for residential development.

In the **Northern Territory**, the NT Planning Act and Planning Regulations provide the legislation for the enactment of the NT Planning Scheme which manages land use and development.

In **Tasmania**, local planning schemes and land use are assessed under the Resource

Management and Planning System and Resource Planning and Development Commission.

4.2.1 Solar vs. Ventilation Orientation in Lot Design

Most policies have criteria for solar access and orientation for the lots but very few local planning schemes have specified Performance Criteria for the siting of lots to respond to prevailing winds for better natural ventilation of the dwelling. The Gold Coast Planning Scheme was found to contain specific Performance Criteria for subdivision layout to maximize cooling breezes. Most other local planning schemes only have criteria for solar orientation, either for the building envelope itself or for the orientation of the building on the lot. Further examples will be given in Section 5 of this report.

4.2.2 Energy Efficiency and Lot Design

Many of the policies relating to subdivision design and their response to prevailing winds are only obliquely referenced in Energy Efficiency sections of a council's DA approvals, though it is recognized that energy efficiency begins with the subdivision of the land before the design and construction of a building, for example the Greenfield subdivision section of the Energy Efficiency Guidelines of Lake Macquarie City Council.

Star ratings for energy efficiency of subdivision lots have been recommended in the Solar Access for Lots document by SEDA but this document has been revised recently with the removal of the star rating for lots as it "seeks to control the placement of the dwelling on a lot to ensure solar access rather than simply the control of the lot size directly." [28] Almost all of the energy efficiency ratings refer to the building itself.

4.3 Regulatory vs. Voluntary Compliance

In the discussion paper "Towards Sustainable Housing in Queensland" [29] and its companion paper "Regulatory Impact Statement"[30] put forth by the Queensland Department of Local Government and Planning and the EPA, four regulatory options were investigated in the discussion of whether regulatory measures should be introduced to amend its building regulations in order to reduce GHG emissions by requiring energy and water efficiency compliance in buildings. The options were:

1. No regulation – business as usual scenario
2. Mandatory State-wide regulation
3. State regulation with local government discretion – model code
4. Planning scheme – local government initiative

Though the discussion centred on sustainable buildings rather than subdivision lots, the notion of regulatory versus voluntary compliance is relevant to note in this report. Option 2 – mandatory state regulation was concluded on page 3 of the Regulatory Impact Statement report to be the preferred approach as it was believed to result in a uniform standard across the State. Uniformity of requirements was believed to "make it easy for builders and buyers to know the minimum standards."[30]

5. COMPARATIVE STUDY

This part of the research is reported in a table format for comparison of the different pieces of legislation that are in effect in the different States. The information is gathered from State-level legislation, local Planning Schemes and other associated recommendations in relation to the requirement for a lot's access to breezes and related energy efficiency requirements at the subdivision stage.

The information includes both legal codes that have to be followed as well as non-binding but recommended guidelines and design principles. The information that is gathered from Local Planning Schemes is not exhaustive but contains examples that have been chosen from various councils to illustrate the varied approaches to this issue of lot configuration and passive ventilation.

5.1 State by State Summary

It can be seen from the ensuing section that some States have very little information in relation to breeze or solar access for subdivisions but a summary of all States is given in order to gain a broad understanding of the different legislative requirements within the country regarding passive ventilation requirements.

The section on **Queensland** is elaborated a little further than others as more examples have been retrieved at the local or State government levels which acknowledge the breeze benefits for passive ventilation. The South-east Queensland Regional Plan sets out thirteen subtropical design principles to encourage the design and siting of new development and buildings to respond more effectively to local climate.

The R-Codes in **Western Australia** make reference to orientation for ventilation for subdivision planning while other complementary policies such as Liveable Neighbourhoods encourage improved energy efficiency of lot design as well.

In **Victoria**, the ResCode and Sustainable Neighbourhoods recommend design strategies for energy efficiency and solar orientation but make no mention of lot orientation for natural ventilation.

The Solar Access for Lots contains guidelines for residential subdivision in **New South Wales** but the document refers primarily to solar and not wind access. Some local councils have Energy Efficiency or other Development Guidelines that encourage applicants to give consideration to prevailing seasonal winds as part of a Site Analysis requirement.

In the **Australian Capital Territory**, most of the references to air movement relate mainly to the building envelope rather than at the subdivision level through such guidelines as the ACT Residential Guidelines and Territory Plan.

Not unlike the other States, **South Australia** has no overt reference to passive ventilation in subdivision planning at the State planning strategy levels. However, other documents such as the South Australian Housing Code and the Good Residential Design SA promote energy efficiency and solar orientation in subdivision layout with limited reference to lot layout for passive ventilation.

In the **Northern Territory**, recommendation for lot orientation to take advantage of prevailing winds and sunlight was found in the NT Planning Scheme.

In **Tasmania**, no current incentives or legislation were found at State legislative level that related to orientation of lots for passive cooling but specific information relating to the siting of a residential development for passive ventilation was found in local planning schemes such as the Hobart City Planning Scheme.

QUEENSLAND	
Integrated Planning Act 1997 (IPA)	Primary legislation guiding planning and development assessment in Queensland. It provides the legislative basis for regional plans and local government planning schemes. "The express purpose of the IPA is to seek to achieve ecological sustainability" and as such, the IPA contains operational guiding principles and 16 ecological sustainability principles which need to be addressed in the application process. [31]
Queensland Residential Design Guidelines[9] (superceded) **SEQROC – Sustainable Housing Code** (draft)	Encouraged "lots to be oriented to facilitate the siting of dwellings to take advantage of microclimatic benefits, and have dimensions to allow adequate on-site solar access and **access to breezes** (especially in the hot-humid tropics), taking into account likely dwelling size and the relationship of each lot to the street."[10][32] Portions of the draft Sustainable Housing Code[34] developed by South East Queensland Regional Organisation of Councils (SEQROC) in 2004 have been incorporated into Parts 25 and 29 of the QDC.
Queensland Development Code (QDC)	Mandatory standards in the Queensland Development Code are in addition to the Building Code of Australia. They refer primarily to buildings rather than lots. [33] No reference to natural ventilation is made in Sustainable Buildings section[11] as it only refers to water conservation, energy efficiency, lighting and hot water supply. Parts 11 and 12–Design and Siting Standards for Single Detached Housing on Lots under and over 450m² list Performance Criterion P2 only for buildings and structures "to allow adequate light and ventilation to habitable rooms and also to habitable rooms of buildings on adjoining lots."
SEQ Regional Plan 2005 – 2026	The SEQ Regional Plan[35] is a statutory instrument that takes precedence over all other planning instruments for planning and development assessment. It provides a broad perspective for planning issues as it would involve more than one local government in matters such as significant urban metropolitan growth, major transport and services infrastructure. Though the SEQ Regional Plan does not refer to lot orientation, it does provide broader design principles for the subtropical climate of South-east Queensland. Part F – Regional policies of the SEQ Regional Plan encourages the design and siting of new development to reflect SEQ's subtropical climate and recommends that buildings should be orientated to respond to local climatic conditions. Refer Policy 8.3.1 - "Ensure all new development incorporates subtropical design principles, including orientation, siting and passive climate control." Section 8.3 Urban character and design states that "climate responsive building, or passive climate control, involves using natural ways to reduce energy consumption through design, construction and use of materials appropriate

[9] No longer in publication and is superseded by the Queensland Development Code.
The Queensland Residential Design Guidelines have been replaced by parts 11 and 12 of the Queensland Development Code.

[10] Refer P6, Element A9 Lot Layout in section on Subdivision of the Qld Residential Design Guidelines

[11] Part 29 – Sustainable Buildings (effective date 1 Mar 2006)

	to a specific climate" One of the key subtropical design principles for SEQ is proper orientation for natural ventilation - "design for appropriate climate-based orientation, provide shade and **allow for the penetration of breeze**, sunlight and the natural environment, integrate with nature." (Section 8.3 Urban character and design)
Environment Protection Agency – Qld	The EPA-Qld fact sheet Sustainable design principles for improved residential developments encourages designers of energy-efficient buildings to apply passive design principles to provide natural comfort by optimising on solar orientation of lots and maximising cross-ventilation.[36]
Guidelines Toward a more Sustainable Subdivision – Dept of Public Works, Qld Govt	The Subdivisional Guidelines from Public Works encourages energy conservation in lots by advising that they be "sited and designed to minimise energy consumption and to achieve the greatest possible thermal comfort with the minimum use of mechanical heating and cooling systems." Maximising of site potential such as wind/breeze direction and surrounding vegetation is encouraged as well as the orientation of internal rooms and buildings for the capturing of "prevailing breezes is very advantageous in subtropical and tropical climates during the hot, humid summer months." [37]
Local Government Planning Schemes	Planning schemes are prepared by local governments under the Integrated Planning Act 1997[12] and are tools for guiding and managing development. Some local planning schemes address the issue of natural ventilation and siting of lots and streets to maximise prevailing winds while others have only passing references to building envelope or building orientation only. **Brisbane City Council (BCC)** Generally, subdivision development in Brisbane must comply with provisions of the Brisbane City Plan[42] and other related codes such as the Energy Efficiency code, House codes, etc. Although there is no overt requirement for lot orientation to prevailing winds, the Subdivision Code of Brisbane City Council, Performance Criterion P4 of 5.1.7 Lot Layout, requires that "lots must be designed to facilitate the siting of buildings to take advantage of microclimatic benefits, and have dimensions to allow adequate on-site solar access and **access to breezes**" No Acceptable Solution is prescribed as it is acknowledged that each subdivision requires an individual approach. There is also an oblique reference to climate-appropriate design in the Subdivision Code of Brisbane City Council Performance Criterion P1.6 of 5.1.1 Neighbourhood Design, which states that "the street and lot orientation and lot dimensions must facilitate the siting and design of dwellings that conserve non-renewable and renewable energy sources and assist in achieving design appropriate for the climatic conditions:" Again, here no Acceptable Solution is prescribed as each subdivision requires an individual approach. The Energy Efficiency Code refers primarily to residential buildings and requires that an energy rating of 3½ stars has to be obtained from an accredited assessor using a House Energy Rating Scheme recognized by BCC. Performance Criterion P10 requires that "buildings must provide an acceptable level of indoor comfort during a typical year in Brisbane", or compliance with specific requirements in P11 to P15. Reference is made in P15 that the building "must achieve an acceptable level of cross ventilation through habitable rooms". Acceptable Solutions deal with the building envelope and relate to positioning of windows and provision of direct air flow

[12] The IPA 1997 has replaced the Local Government (Planning and Environment) Act 1990

paths.

Rochedale Draft Principles

Early intentions in Rochedale's Draft Principles (no longer current), as described by Deicke Richards[25], required "site planning and landscape design to allow and **support channeling of desirable breezes** considering the site's micro-climate." It was also noted that optimum lot orientation, sizes and dimensions were important to support optimum building and house design.

There is no specific reference to design for prevailing breezes in the current Draft Rochedale Urban Community Local Plan (under Brisbane City Council).[40] It only encourages, in page 1, Development Principle 2.3, that "sustainable, subtropical design principles will be reflected through the design of neighbourhood structure plans, building siting and design, construction and management. Development will result in landscapes that contribute to subtropical design and lifestyle. Street trees will provide shade and landscape amenity for the community."

Gold Coast Planning Scheme

In the Gold Coast Planning Scheme, the Planning Scheme Policy 5 Energy Conservation (Design for Climate) and Chapter 10 Energy Conservation under Planning Strategy outline desired design principles for subdivision layout that maximizes opportunities for solar access and cooling breezes – "ensure that the street layout and the lot layout do not restrict cooling summer breezes." Subdivision design is also encouraged to include variable setbacks and zero lot lines "as a means of maximizing solar access and opportunities to capture breezes especially small and narrow lots" The Performance Criteria in this section are outlined in terms of energy usage based on GFA and kWh/m²/annum energy used and do not refer to lot orientation, although the purpose of this Policy 5 is to increase energy efficiency design of buildings and subdivisions through lot and street layout and building siting. [38]

The Gold Coast Planning Scheme is specific in its requirement for lot orientation. In Part 7 Codes, the Energy Efficient Design section requires that Performance Criteria 14 and 15 relating to lot orientation be achieved. PC 14 states that "street and lot orientation must facilitate the construction of energy efficient buildings that respond to the local climate conditions" such as "**maximizing access to any prevailing summer breezes and minimizing exposure to prevailing winter winds**." PC 15 requires that "lots are to provide favourable solar access and to allow potential dwellings to **take advantage of breezes** and other positive natural attributes" There is no Acceptable Solution provided.[39]

Ipswich Planning Scheme

Similar local climate-responsive design is mentioned the Climate Control Specific Outcomes Section 12.5.3 Lot Layout and Design of the Ipswich Planning Scheme. However, there is more reference here given to the siting of buildings rather than the lot itself, where buildings are to be sited and designed to **maximize use of prevailing breezes for natural ventilation**. (refer 12.6.4 Residential Uses and Works – Effects of Development – General Provisions) [41]

WESTERN AUSTRALIA	
Western Australia Planning Commission	In WA, three main documents impact on subdivision planning – the WAPC, R-Codes and the Liveable Neighbourhoods Edition 2. The WAPC [43] is a statutory authority that coordinates the State's planning process and integrates land use planning and development in WA. Together with local governments, the WAPC is involved in subdivision approvals through instruments such as regional schemes and state planning policies.
Residential Design Codes (R-Codes) Oct 2002	The Residential Design Codes were prepared by the WPAC and, through local government, the R-Codes [44] provide the basis for siting and design of residential development throughout Western Australia. The R-Codes are not subdivision standards, though they are standards for the control of development of subdivisions. They contain Objectives, where the aim of a design element is stated, and Performance Criteria that must be satisfied. The objectives can also be met through a "deem to comply" route under Acceptable Development sections. The R-Codes are to be complementary with the BCA. For example, the R-Codes address solar access with respect to adjoining sites for new development while the BCA Energy Efficiency Amendment addresses the energy efficiency of the built fabric of housing. Part 2 of the General Provisions of the R-Codes requires the submission of a Site Analysis Plan in which there is a suggestion to include the direction of prevailing winds – "it is desirable to include the **direction of cooling breezes** and areas exposed to winter sun" (ref: Part 2 of the General Provisions of the R-Codes) In the R-Codes, Part 3 Design Elements, there is a reference to orientation for ventilation for subdivision planning in Element 9 Design for Climate, where energy conservation and comfortable living is encouraged through design that takes into account that "**cooling breezes in summer come to the Swan Coastal Plain from the south-west; design should allow for letting these in while protecting windows from the sun, and avoiding crowding shrubs so close that they will hinder breezes**." Also, **"in the hot humid regions thorough ventilation (and hence space around buildings) and shade are more important than solar penetration in winter**." (ref: Element 9 Design for Climate of Part 3 Design Elements of the Residential Codes Oct 2002) Element 3.9 Design for Climate of the R-Codes states that it is difficult to translate the aims of climate-sensitive design into development provisions "because conditions vary greatly from one situation to another, making it difficult to establish universally valid rules." As "it is impossible to adequately codify and enforce good design practice", the R-Codes aim to deal with the issue in other ways such as setting out the relevant factors for the design of a development, setting down conservative Acceptable Development limits to overshadowing, and encouraging designers and councils to utilize the performance approach. Neither the BCA nor R-Codes have mandatory requirements for ventilation orientation in lot design. The BCA only specifies a ratio of window area to habitable room area, and a breeze path, but does not address orientation to prevailing winds or the

	influence of boundary walls on available breezes. Although there is currently no definitive measure for lot orientation and ventilation, the Planning Bulletin No.77 WAPC Mar 2006[45] highlights design issues such as lot orientation and design for ventilation which are currently not recognized by the R-Codes and are to be addressed in a future review of the R-Codes.
Liveable Neighbourhoods Edition 2, June 2000 (Ed. 3, 2004 draft)	The WAPC has made provisions for improved energy efficiency lot design in the Liveable Neighbourhoods Edition 3 [46] which the R-Codes also complement. The Liveable Neighbourhoods Edition 2 is an operational policy on trial since February 1998 which has enabled developers to choose this policy as an alternative to the current WAPC policies for subdivision design. In the Application Requirements checklist of this policy, climate-responsive design for lot layout is not mandatory for subdivision planning approval, as only information/detail is required. Requirement 20 of Lot Layout states that "lots in hot humid and hot arid climates should be orientated to facilitate the siting of dwellings to take advantage of micro-climatic benefits, **including cooling breezes,** shading and canopy vegetation." (refer R20 of Lot Layout – Liveable Neighbourhoods Edition 2)

VICTORIA	
Victoria Planning Provisions (VPP)	In Victoria, residential subdivisions are required to adhere to local planning schemes which in turn are informed by the Victoria Planning Provisions. The VPP[47] is a Statewide reference document or template from which planning schemes are sourced. It is a comprehensive set of standard planning provisions and provides a standard format for all Victorian planning schemes. Only the Minister for Planning can amend the VPP.
ResCode	The ResCode[48] is a package of provisions for residential development that came into effect across Victoria on 24 August 2001. It is not a single document but is incorporated into planning schemes and Building Regulations. ResCode replaced the Good Design Guide for Medium Density Housing and the Victorian Code for Residential Development (Subdivision and Single Dwellings) – VicCode 1 on 24 Aug 2001.
Sustainable Neighbourhoods **Clause 56** **Department of Sustainability and Environment**	Sustainable Neighbourhoods[49] documents contain new provisions for residential subdivision that came into effect on 9 October 2006. It is a package that implements State Government policy to achieve more livable and sustainable communities. Within this document is a revised Clause 56 which sets out the objectives that a residential subdivision application must meet for design responses to site and neighbourhood. However, there is no reference to lot orientation for natural ventilation in this Clause. Clause 56.04 Lot Design indicates the objectives of solar orientation of lots and Clause 56.01 Subdivision Site and Context Description and Design Response refers only to siting in relation to existing structures, views, etc. Neither of these 2 clauses in the new Sustainable Neighbourhoods package have any provisions for design responses to prevailing winds or natural ventilation for building or subdivision design
Energy Efficiency Ratings	On 1st March 2002, Victoria required that two or more dwellings on a residential lot should be designed to achieve a four-star energy efficiency rating using the Sustainable Energy Authority of Victoria's FirstRate[50] house energy rating software or equivalent. Design strategies that are recommended for achieving the required energy ratings refer to the building and not the lot itself.
Local Government Planning Schemes	Most of the planning schemes refer to Clause 56 Lot Layout and Design but this clause has little reference to lot design in response to prevailing winds. The City of Yarra[51] has published Sustainable Design Guidelines to make accessible to the public, some building and planning information on passive solar design, insulation and other design strategies to meet the city's Greenhouse Action Plan. As with other local planning schemes, orientation of buildings to capture breezes for passive ventilation is referred to in passing in Site Plan Analysis only and virtually no information is available on lot orientation at the subdivision level.

NEW SOUTH WALES	
Solar Access for Lots by SEDA (Sustainable Energy Development Authority)	The Solar Access for Lots[28] document contains guidelines for Residential Subdivision in NSW. It is a tool designed by SEDA to help greenfield developers place a "dwelling on a lot to ensure solar access rather than simply control the lot size directly." Local councils in NSW can apply this tool as a voluntary or mandatory control for new subdivisions. This tool replaces the Solar Access for Lots guidelines previously found in the Energy Smart Homes Policy. **This newer set of guidelines eliminated star ratings for lots.**
Building Sustainability Index (BASIX)	In NSW from 1 July 2005, all new residential development required BASIX certification[52]. As seen in other jurisdictions, energy rating schemes such as BASIX which are required at Development Application level usually relate to building envelope or siting of building rather than the siting of the lot in a subdivision.
Local Planning Schemes	Lake Macquarie Planning Scheme In the Energy Efficiency Guidelines[53] of Lake Macquarie City Council, Section 4.2 Infill Subdivision, all urban infill subdivision is encouraged to consider site constraints such as overshadowing, orientation and **prevailing seasonal winds** as part of a normal site analysis prior to determining the most suitable subdivision layout. In Section 4.3 Greenfield Subdivision of these Guidelines, it is stated that "for Greenfield Subdivision, energy efficient subdivision design shall take account of on-site features…and maximize solar orientation to living areas and **breeze access generally to all parts of the house** " (refer LMCC Energy Efficiency Guidelines – Revision 01 Page 10) With these guidelines, Lake Macquarie City Council requires an Energy Efficiency star rating for each lot for subdivision plan submission but this rating relates primarily to solar access rather than natural ventilation. Performance Criterion P1 under Section 2.1.14 Energy Efficiency requires that "the subdivision of land achieves a high level of energy efficiency through lot layout design, including street and lot orientation, and lot size and shape" for which the Acceptable Solution is that "subdivision is designed in accordance with "Solar Access for Lots – Guidelines for Residential Subdivision in NSW (SEDA)" [53] (refer LMCC DCP No.1 – Revision 01 Part 2.1 – Environmental Responsibility and Land Capability Page 80 - F2004/11035 adopted by council 30 January 2006) Also, Performance Criterion P1.5 under Section 3.2.1 Neighbourhood Design requires that "street and lot orientation and lot dimensions facilitate the siting and design of houses or buildings that conserve non-renewable and renewable energy sources and assist in achieving design appropriate for the local climactic conditions". The Acceptable Solution given is the ability to satisfy the Performance Criteria by preparing a Site Analysis Plan [53] (refer LMCC DCP No.1 – Revision 01 Part 3.3 – Subdivision Page 15 - F2004/11035 adopted by council 30 January 2006) Eurobodalla Planning Scheme The Development Guidelines – Subdivision of Eurobodalla Residential Design Code, Section 2.3.1 Energy Efficiency pg.22, states a design principle that "as lots are correctly aligned and proportioned. Individual dwellings will generally perform better in terms of energy use with

	comparatively less effort." An Acceptable Solution is that "streets and lots are orientated to maximize solar access for dwellings wherever possible, **and/or are orientated to facilitate cross-ventilation of cooling breezes through sites** and the use of passive solar design" [54] Other Local Planning Schemes Other local councils such as the City of Gosford have little reference to cooling breezes but require provision of details such as Site Analysis (detailing site characteristics such as prevailing winds) and Solar access star rating for each lot for Development Applications.[55] (refer DCP 108 Energy Smart Homes Part 1-Land Subdivision, pg 3) Similarly, Lismore City Council [56] in its Energy Smart Homes Information Package shows how prevailing winds can have a significant cooling effect, thereby achieving effective ventilation for residential buildings. The information refers to buildings and not lots and the energy efficiency in this case, however, is achieved through House Energy Rating Assessments.

AUSTRALIAN CAPITAL TERRITORY	
Achieving Sustainable Residential Development by ACTPLA	The ACT Planning and Land Authority (ACTPLA) has developed Achieving Sustainable Residential Development - Design for a Sustainable Lifestyle as a guide to "assist designers to consider issues such as how to site and design a house to make the best use of Canberra's climate" and to "achieve sustainable residential development in the ACT" [57] One of the considerations raised in this guide was that the impact of a proposed development must consider issues such as the reduction of greenhouse gas emissions, using passive solar design principles and **maximising the use of natural daylight and ventilation**. The section on Space Heating and Cooling encourages **cross ventilation** to reduce residual summer heat, fungus and bacteria.
ACT Residential Guidelines	Page 3 of the ACT Residential Guidelines states that "since 1 July 1995, in order to improve the energy efficiency of all new residences, the Territory Plan requires all residential design and siting applications to be accompanied by an energy efficiency rating (EER) statement which achieves a mandatory minimum of 4 stars."[58] (refer Page 3 of the ACT Residential Guidelines) The Guidelines recognize that energy efficiency includes orientation and cross ventilation but the design standards refer to the building itself rather than to the subdivision lot.
ACT House Energy Rating Scheme (ACTHERS)	An Energy Efficiency Rating (EER) is required to be submitted as part of the Development Application Submission OR when residential properties are being offered for sale in the ACT.[59] This EER statement must achieve a mandatory minimum of 4 stars and is to be undertaken by an accredited ACTHERS assessor. As of 1 July 2001, all EER assessments are produced by the ACTHERS software model based on FirstRate.
Territory Plan	The Territory Plan 1993 [60] (under the legislative framework of the Commonwealth's Australian Capital Territory Planning and Land Management Act 1988) aims to ensure that the development of the ACT "provides the people of the Territory with an ecologically sustainable, healthy, attractive, safe and efficient environment in which to live, work and have their recreation (refer Territory Plan Part A1: Object and Goals - Section 7(1) of the ACT Land (Planning and Environment) Act.) The codes in the Territory Plan for Element 4 - Site Planning, and Element 12 - Design for Reduced Resource and Energy Consumption, refer to building envelope and siting rather than the subdivision lot. Reference to siting for natural breezes is oblique under Element 4 where Performance Criterion P4.3 states that "the Site Layout needs to take into account on-site features, topography…orientation and microclimate considerations…" Acceptable solutions would entail submission of a detailed site analysis plan demonstrating response of site planning. (refer page 12 of Appendix III.3 of the Territory Plan Urban Housing Code) Under Element 4 Site Planning, Performance Criterion P4.5 requires that "dwellings are sited and designed to provide good solar access to living areas and **allow cross ventilation where possible**." There is no further detail regarding cross ventilation except that the corresponding Acceptable Standard A4.5 requires that dwellings have at least a four

	star energy rating under ACTHERS. (refer page 13 Appendix III.3 of the Territory Plan Urban Housing Code) All reference to ventilation or air movement is mainly to the building envelope and internal layout, for example, Element 12 Design for Reduced Resource and Energy Consumption states that the intent "to facilitate measures to reduce energy, resource and water consumption" may be achieved with P12.1 whereby the "building envelopes and internal layouts" are designed to minimize energy consumed; or with P12.5 where "air movement within dwellings is designed to provide acceptable thermal conditions". Acceptable solutions refer only to dwellings and not the lots in that the buildings have to achieve minimum 4 stars under ACTHERS or have a maximum depth of 12m to facilitate cross ventilation and access to natural light. (refer page 31 Appendix III.3 of the Territory Plan Urban Housing Code)
Energy Guidelines 1993 (no longer available)	The Energy Guidelines 1993[61] was published by the Department of Planning and Land Management ACT as a series of Environmental Planning Guidelines in association with the drafting of the Territory Plan. The Guidelines stress solar orientation as a consideration for energy conservation at the subdivision level especially when "land subdivision and housing layout are conceived and executed together." (Refer Pg 3 PPN13 Energy Guidelines 1993). However, no reference is made to the orientation of the lot or house to maximise natural ventilation obtained from prevailing winds.

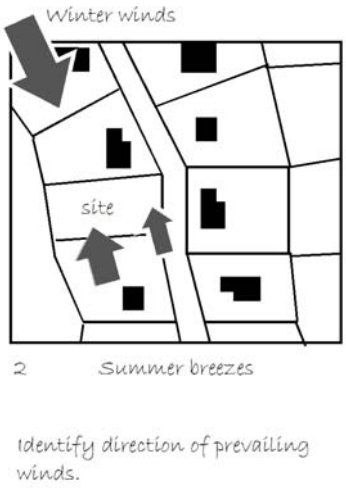
SOUTH AUSTRALIA	
Development Act 1993 **Development Regulations 1993**	The framework for land use and building development in South Australia is provided by the Development Act 1993 and the accompanying Development Regulations 1993. Local councils assess subdivision applications with policies and standards against local Development Plans that have been adapted from these 2 primary legislative documents. [62]
State Planning Strategies 1994 **Metropolitan Development Program 1998**	In 1994, the South Australian Integrated Planning and Development Assessment System[63] came into operation to facilitate the development process and combines all the regulatory requirements such as the Development plans and regulations; Planning strategies such as the State Planning Strategy and Planning Strategy for Metropolitan Adelaide; BCA; and other policies listed below. Although no overt reference to passive ventilation subdivision planning is outlined in policies at this level, a development plan must be consistent with the State Planning Strategy and may also include other policies such as the Good Residential Design or Sustainable Energy Policy listed below.
Development Plan for the City of Salisbury 2006 **Development Information Guide ISO21 Energy Efficient Homes – Yorke Peninsula**	The Development Plan for the City of Salisbury (21 Dec 2006) [64] outlines general principles - "residential development should be appropriately designed to take account of the climatic and topographic conditions of the site." (pg.24) and that "dwellings should be **located** and designed to take advantage of solar access and create desirable microclimatic conditions (through use of sun, shading, ventilation and shelter)." (pg.25) In the Development Information Guide ISO21 Energy Efficient Homes published by the District Council of Yorke Peninsula,[65] the council encourages paying attention to site selection when designing an energy efficient home to **select "the right block and *put* the house in the right place on the block".** It also states that "careful **landscaping design can provide shielding from winds, deflect cooler summer breezes into the house,** reduce glare and generally modify temperatures at all times of the year."
South Australian Housing Code **Appendix H - Energy Efficiency** **Adelaide Metropolitan Area Wind Speed Map**	The main technical documents governing building work in SA are the BCA and South Australian Housing Code [66]. The SA Housing Code sets out "deemed-to-satisfy" provisions for the construction of Class 1a and Class 10a buildings. In section H.2 of Appendix H Energy Efficiency of the SA Housing Code (amendment 13), new residential development will need to satisfy a recognized 5-star energy rating scheme that includes criteria for solar orientation. Provision of adequate cross ventilation for habitable rooms is demonstrated in Figure H6 showing a recommended 20m breeze flow path through a dwelling. These provisions apply to the building itself. The 2002 SA Housing Code also includes an Adelaide Metropolitan Area Wind Speed Map for users to identify areas with higher probability of stronger winds. [66]
Good Residential Design SA	The Good Residential Design SA [67] is a resource document that has its origins in the 1995 AMCORD document, and as part of the State's Planning Strategy provides a framework for the planning process and design guidelines for residential development. Lot layouts for promoting energy efficiency in subdivision layout are

Planning Bulletin Residential Policy ed.2 – July 2001	discussed mainly in the context of solar orientation (refer pg. 31, Element 1.2 Lot Layout – Neighbourhood Design and Movement) where one of the Objectives for residential allotment layout is to "facilitate energy conservation in dwellings", and to achieve this aim, Performance Criterion 3 states that "**residential allotment orientation, size and dimensions should facilitate the siting of dwellings to take advantage of microclimatic benefits**". The illustration given refers to the orientation of lots for solar access and thus passive ventilation can only be inferred as part of the microclimatic benefits. More specific reference to passive ventilation is given on pg.90, Element 4.2 Site Planning where Performance Criterion 3 states that "dwellings should be sited to minimise fossil fuel use, **maximise the beneficial effects of cool breezes in summer and minimise the effects of hot breezes in summer and cool breezes in winter**. No specific Design Technique is given for meeting this PC. On pg.106, (Element 4.5 Energy and Water conservation – Site Planning and Building Design) orientation for air movement is understood to be an important aspect of energy efficiency as "**buildings should be orientated or otherwise designed to receive the prevailing cooling breezes** to harness cooling breezes and providing fresh air indoors especially during warmer months. If this is not possible other strategies, such as deflecting breezes into rooms with fencing or densely planted vegetation can be used." The Residential Policy Planning Bulletin[68] assists "local government to more effectively implement the provisions of the State Planning Strategy" (pg. iii) and is a resource for local government to incorporate the principles of Good Residential Design SA. To achieve its call for energy efficiency, the Bulletin outlines on pg. 37 the Performance Criterion 50 for Energy Conservation and Comfort where "dwellings should provide adequate thermal comfort for occupants while minimizing the need for mechanical heating and cooling" by "**allowing for cross ventilation to enable cooling breezes** to reduce internal temperatures in summer". These Principles for Development Control, however, refer to the dwelling itself rather than the lot it is situated on.
Sustainable Energy Policies **Tackling Climate Change Strategy** **Energy Division advisory**	Sustainable Energy policies by the SA government that make reference to energy efficiency of residential development through lot or building design can be found in SA's Tackling Climate Change Strategy and the Energy Advisory Division of the Department of Transport, Energy and Infrastructure. In Tackling Climate Change Strategy [7] pg. 41, we are challenged to tackle the problem "at all levels of urban planning and design not just individual buildings or infrastructure" which includes solutions for reducing emissions (e.g. energy-efficient subdivision layouts)." Orientation and siting in "Designing an Energy Efficient Home"[69] refers mainly to solar orientation and orientation of building on a lot but designers are encouraged to consider passive ventilation when siting a dwelling – "in summer, a cool breeze flowing through the house helps cool down the house and it's occupants at night. **The house need not face directly into prevailing summer breeze but can be offset at an angle of 45º either way."**

NORTHERN TERRITORY	
NT Planning Act 2005	The NT Planning Act and Planning Regulations provides the legislative framework for the enactment of the NT Planning Scheme, which provides a process for development approval in NT. [70]
NT Planning Scheme (NTPS) 1 Feb 2007	The Northern Territory Planning Scheme [71] is a consolidated document managed by the Minister, containing provisions for land use and development. Part 5 of the NTPS stipulates in section 11.2.3 - Lot Size and Configuration in Residential Subdivisions that "residential subdivision design should provide that **lots are oriented to allow dwellings to take advantage of environmental conditions such as prevailing breezes** and sunlight." In Part 4 of the NTPS, Section 7.0 Residential Performance Criteria subsection 7.8.2 Building Design for Multiple Dwellings states that "building design should (a) locate development on the site to correct solar orientation" and "(j) **allow breeze penetration and circulation.**"
Other energy efficiency programs	Most of the energy efficiency incentives for NT focus on household energy savings, e.g. the Cool Communities program for Darwin and Alice Springs. [72] Participation in the Cities for Climate Change program for the NT does not refer to energy efficiency at subdivision planning stage.

TASMANIA	
Land Use Planning and Approvals Act 1993 **Resource Management and Planning System (RMPS)** **Resource Planning and Development commission (RPDC)**	The Land Use Planning and Approvals Act 1993[73] is the primary legislation in Tasmania for the provision of planning schemes and the development approval process. This legislation is supported by the State Policies and Projects Act 1993. Local planning schemes and land use are assessed under the Resource Management and Planning System (RMPS) 1994 and the Resource Planning and Development Commission (RPDC) The RMPS was established "to achieve sustainable outcomes from the use and development of the State's natural and physical resources" while the RPDC is an independent statutory body that oversees the State's planning system and is responsible for assessment and approval of local government planning schemes and other development plans. [73] "The Department of Justice provides policy direction related to the State's statutory lands use planning processes and other planning legislation." [73]
Hobart City – Planning Scheme and Energy Efficiency Guidelines	Hobart City Council's planning scheme does not dictate any provisions for passive ventilation for subdivision planning but it has developed initiatives encouraging energy efficiency in new homes and the Energy Efficiency Design Guidelines[74] contain clear principles for passive ventilation and solar orientation. Specific information was found for the siting of a residential development in response to the need for passive ventilation. In Principle 1, Site Analysis, the guidelines encourage identification of the "**direction of prevailing summer breezes which can be used for summer cooling** – generally from south-east to south in Hobart" and also to "**identify direction of prevailing winter winds from which the house needs to be protected** – generally from north-west in Hobart." (See Figure 5-1 on next page) In Principle 4, Ventilation and cooling, it is acknowledged that "in Tasmania, attention usually focuses on providing warmth in winter, without much thought to ventilation and cooling in summer. Often there is scope to accommodate both at the same time." The guidelines state that "**prevailing natural breezes can be used to provide ventilation**" and "careful thought to building design, in particular window location, size, and type, can reduce reliance on artificial ventilation systems (such as air conditioning and electric fans." Although advice in Principle 4 refers to siting of the building, the notion of orientation of "buildings to benefit from south/easterly to southerly cooling afternoon summer breezes" is specific and directs the reader to consider orientation for passive cooling.
State of the Environment Tasmania – Urban Design and Sustainable Housing	There was found to be no current incentives or legislation specifically directed at orientation of lots for passive cooling in either the Sustainable Housing or Urban Design sections of the department of the State of the Environment Tasmania though there is an awareness of the "development of sustainable housing and 'green' buildings". The issue of energy efficient housing and star ratings is identified as a current key issue. [75]

Figure 5-1 Site analysis – Hobart City Council's Energy Efficiency Design Guidelines



6. CONCLUSION

It can be seen from the Comparative Study of the preceding section that current legislation and guidelines at different levels of government make various general inferences rather than specific performance based design criteria for natural ventilation in sustainable subdivisions. Energy savings are acknowledged as a possible outcome of correct orientation but no overt ratings are used for natural ventilation criteria.

This research confirmed that many of the regulatory requirements for energy efficiency or initiatives for sustainability focused on the building itself or the orientation of the dwelling on the lot. If there is any reference to specific regulatory requirement, the focus is usually on the orientation of the lot or building for solar access rather than for breezes.

Similarly, the guiding principles for increasing energy efficiency or reduction of greenhouse gas emissions for subdivision planning do not specifically refer to increasing passive ventilation with lot orientation. Rather the orientation of lots to maximise natural ventilation is usually included in siting for overall microclimatic conditions.

Our research carried out for this report revealed that different state and local governments have their own legislative framework for sustainability and energy reduction in relation to buildings or subdivisions. There is no uniformity among the States though many of these criteria are adapted from general principles that are put forward by national government agencies.

Findings from the research in this report are intended to contribute to the discussion on the development of an enhanced lot rating methodology for sustainable subdivisions as documented in other reports in this series.

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